Morton International Salt Group
Mechanical Integrity Test for Significant Casing Leaks (MIT Part 1)
using the
Water-Brine Interface Method
Data Collection and Report Form

The test is an alternative method for satisfying the requirement of 40 CFR 146.8 (b) for the demonstration of no significant leaks in the casing, tubing, or packer. (The demonstration is sometimes referred to as "MIT Part 1" or as "internal mechanical integrity.") The U.S. EPA noticed approval of the Water-Brine Interface Method as an alternative mechanical integrity test for Class III salt solution mining wells on a national basis in the Federal Register, Vol. 57, No 7 of January 10, 1992, pages 1109-1112.

Use this Data Collection and Report Form in conjunction with the "Morton International Salt Group Guide for Conducting a Mechanical Integrity Test for Significant Casing Leaks using the Water-Brine Interface Method," version 2.0 or later.

1. Summary

Permit issued by: **US EPA** Permit No.: **R9UIC-AZ3-FY08-1** Well I. D. in Permit: **AZR000000240** Result: _____

2. General Information

Company: **Morton Salt, Inc** Facility: **Morton Salt Glendale, AZ Facility**

Complete Address (Street and number, city, state, ZIP) 13000 W Glendale Avenue, Glendale, AZ 85307

Complete Mailing Address: _____

Contact Person: Blaine Godfrey Telephone: 623-247-3000 x 3107

Field: **RB # 5** Test Well: **Annulus** Reference Well: **Tubing**

Location of Test Well: Township: T2N Range: R1W Section: SW 1/4 SEC 2

Other (if no township/range): _____

County: Maricopa State: AZ

Other Wells in Gallery: None

Salt Formation Name: Luke Salt Body

3. Regulatory Agency Approval and Notification

Describe: (a) request to the regulatory agency for authorization to use the test method, (b) regulatory agency approval, (c) notification of the test schedule, (d) approval of the test schedule, and (e) whether a regulatory agency representative must be present.

(a and c) Morton Letter to USEPA Dated November 21, 2017.

(b and d) USEPA verbal approval on February 20, 2018

(e) whether a regulatory agency representative must be present. Ryan Fitzpatrick

Company: **Morton Salt** Facility: **Glendale, AZ** Field: **RB # 5** Test Well: **Annulus** Date: **February, 2018**

4. Test Well Data (If tubing is installed, the annulus is the test well.)

Well Annulus	Data	Data Source	Datum*
Depth of surface casing, feet	450'	UIC permit completion repo	GL
Depth to top of salt formation, feet	862'	UIC permit completion report 5/1/2014	GL
Depth to top of cavern (if known), feet	1580'	UIC permit completion repo	GL
Depth to bottom of casing, feet	1580'	UIC permit completion repo	GL
Depth to bottom of tubing (if present), feet	1975' and 3477'	UIC permit completion repo	GL
Depth to current bottom of cavern (if known)	3560'	UIC permit completion repo	GL
Depth to original bottom of cavern, feet	3560'	UIC permit completion repo	GL
weight, pounds/foot	13 3/8", 54.5 lbs/ft	UIC permit completion report 5/1/2014	
Outside diameter of tubing (if present), inche	10 3/4" and 7"	UIC permit completion repo	
Capacity of casing or annulus, gallons/foot	1.7779	Halliburton Tables	
Volume of casing or annulus, gallons	2809	Volume calculation	
Type of pad (none, mineral oil, diesel oil, air,	None		
Volume of pad (if present), gallons	None		
Normal operating pressure at wellhead, psi		Plant records	
for injection? (Yes or No)		Plant records	

* Datum: KB = kelly bushing, WF = wellhead flange, GL = ground level, DF = drill rig floor
Datum: KB = feet above ground level

Company: **Morton Salt** Facility: **Glendale, AZ** Field: **RB # 5** Test Well: **Annulus** 13 3/8 x 10 3/4 Date: **April, 2018**

5. Reference Well Data (If tubing is installed, the annulus is the test well. The reference well may be the tubing of the test well, the annulus of another well with tubing or another well without tubing. The reference well must be in the same gallery as the test well.)

Well Tubing	Data	Data Source	Datum*
Depth of surface casing, feet	450'	Completion Report 5/1/201	GL
Depth to top of salt formation, feet	862'	Completion Report 5/1/201	GL
Depth to top of cavern (if known), feet	1580'	Completion Report 5/1/201	GL
Depth to bottom of casing, feet	1580'	Completion Report 5/1/201	GL
Depth to bottom of tubing (if present), feet	1975' and 3477'	Completion Report 5/1/201	GL
Depth to current bottom of cavern (if known)	3560'	Completion Report 5/1/201	GL
Depth to original bottom of cavern, feet	3560'	Completion Report 5/1/201	GL
weight, pounds/foot	10 3/4" tubing, 45.5 lbs/ft	Completion Report 5/1/201	
inches and weight, pounds/foot	7"	Completion Report 5/1/201	
gallons/foot	2.04	Halliburton Tables	
Volume of casing or annulus or tubing, gallo	4029	Calculation	
Normal operating pressure at wellhead, psi	325	Plant records	

* Datum: KB = kelly bushing, WF = wellhead flange, GL = ground level, DF = drill rig floor

Datum: KB = feet above ground level

KOP= feet

Company: **Morton Salt** Facility: **Glendale, AZ** Field: **RB # 5** Test Well: **Annulus** 7 x 10 3/4 Date: **February, 2018**

6. Pressure Gages

Well	Manufacturer	Model
Test Annulus	Mensor	Series 6000
Reference Tubing	Mensor	Series 6000

7. Determine Target Depth for Interface

The target depth is 50 feet above the bottom of the casing unless the casing extends more than 50 feet below the estimated top of the cavern, then the interface may be established up to 50 feet above the estimated top of the cavern.

Depth to bottom of casing: **1580** feet Depth to top

Comment (optional): _____

_____

_____

8. Bring Cavern to at Least Normal Operating Pressure

If necessary, inject to bring the cavern to at least the normal operating pressure. The wellhead pressure of the test well must be at least 100 psi after injecting the water (or oil) to the target depth of the interface, unless the Director permits testing at a lower pressure.

9. First Pre-Flush of Test Well

Pump a minimum of one casing volume of water into the test well to dissolve any salt that may be crystallized on the casing string. Either measure the quantity injected or inject until the wellhead pressure stops increasing.

Date and time first pre-flush water injected: Date: _____

Explain the method that was used to insure that at least one casing volume of water was injected:

gallons were inject

Total gallons injected is less than casing volume!

10. Wait One Day (Approximately 24 hours)

Serial Number	Sensitivity	Conversion factor (psi/gm)
860851	0.01 psi	N/A
860850	0.01 psi	N/A

of cavern: **1580** Target depth for interface: **1530** feet

Casing volume = **2809** gallons

Time:

Flow meter used to measure volume.

ed, which is gallons greater than casing volume.

Field: **RB # 5** Test Well: **Annulus** Date: _____

11. Second Pre-Flush of Test Well

Not required if the 24 hours of operation immediately before starting the test were for injection.

12. Wait One Day (Approximately 24 hours)

Not required if step 11 not required.

13. Bleed Back Reference Well

Bleed back the reference well until specific gravity is constant.

Shut in the well. Although not required, installing blanks to isolate the well is very strongly recommended.

14. Bleed Back Test Well #38

Bleed back the test well until specific gravity is constant.

Shut in the well.

15. Determine Whether Oil or Water is to be Used for the Test Well Injection Fluid

If the specific gravity of the test well fluid as determined in step 14 is less than 1.100, then the fluid to be injected above the interface must be an oil with a specific gravity less than 0.9; otherwise, either oil or water may be used. It is a Morton International Salt Group internal standard that the oil must be FDA approved for use as a food additive. Comment on what will be used.

Date and time second pre-flush water injected: Date: _____ Time:

Explain the method that was used to insure that at least one casing volume of water was injected: Flow meter used to measu

gallons were injected, which is gallons greater than casing

[redacted]

Specific gravity of reference well fluid: _____ (Record to three decimal places, do not adjust for temperature.)

Date and time reference well bled back: Date: _____ Time:

_____

ll

Specific gravity of test well fluid: _____ (Record to three decimal places, do not adjust for temperature.)

Date and time test well bled back: Date: _____ Time:

Since the specific gravity of test well fluid as determined in step 14 is: _____ mineral oil must be used.

re volume.

; volume.

Annulus Date: **February, 2018**

16. Inject Water or Oil in Test Well to Establish Interface

a. Calculate the maximum injection rate for a maximum velocity of 20 feet per minute.

Capacity of casing or annulus		Maximum injection velocity		Maximum injection rate
_____ gal/ft	x	feet per minute	=	_____ gallons per minute

b. Explain how the injection rate will be controlled to insure that the maximum injection velocity will not exceed 20 feet per minute:

Valve throttled back and rate monitored using flow meter.

c. Determine by calculation the desired change in the pressure difference between the test well and reference well before and after injecting the water or

Target depth for interface (from step 7)		Specific gravity of brine in test well (3		Specific gravity of water or oil (3 decimals)		Conversion factor	
_____ ft	x	(_____	-	_____)	x	0.4331 psi/foot	=

d. Inject water or oil

	Date	Time	Reading No.	Test well pressure, psi	Reference well pressure, psi	Pressure difference between Test and Reference wells, psi
Before Injecting			1			
1st reading while injecting*			2			0.000
2nd reading while injecting*			3			0.000
3rd reading while injecting*			4			0.000
Final reading			5			0.000

* Optional ** The pressure difference for this reading minus the original pressure difference.

Checks:

$$R = \frac{C \times 20}{D} = \text{\#DIV/0!} \quad \text{psi/min}$$

= Maximum rate of change of pressure difference

#VALUE!

ENTER PRESSURE TOO LOW

Company: **Morton Salt** Facility: **Glendale, AZ** Field: **RB # 5** Test Well: **Annulus** Date:

oil.

Change in pressure difference

_____ psi 138.24552

Total change in pressure difference between Test and Reference wells, psi **
XXXX
#VALUE!
0.000
0.000
#VALUE!

SEE STEP 8.

16. Inject Water or Oil in Test Well to Establish Interface (Continued)

e. Calculate the actual depth of interface.

Change in difference*		Specific gravity of brine in test well		Specific gravity of water or oil		Conversion factor
#VALUE! psi	x	(1 /	-	)	x	1 / 0.4331 psi/foot

* Final reading, total change in pressure difference between Test and Reference wells from step 16d.

f. Comment on whether the interface has been properly placed: #VALUE!

g. Although not required, installing blanks to isolate the test well is very strongly recommended.

h. For information purposes only, what other wells in the gallery were operated while the water or oil was being injected?

17. 36 Hour Temperature Equilibrium Period

Wait at least 36 hours for the fluids in the test and reference wells to come to temperature equilibrium. At the end of the temperature equilibrium period take a set of pressure measurements and evaluate whether the change in pressure difference is significant.

a. Take pressure measurements

	Date	Time	Reading No.	Test well pressure, psi	Reference well pressure, psi	Pressure difference between Test and R wells, psi
Start of temperature equilibrium period*			1			0.000
1st reading after start**			2			
2nd reading after start**			3			
3rd reading after start**						
hours after start			3			0.000

* Identical to the final reading for injecting the oil or water, step 16d.

** Optional, it is suggested that two or three readings are taken during the temperature equilibrium period to help analyze whether there are any trends.

*** The pressure difference for this reading minus the original pressure difference.

Check: Equilibrium period was

Depth of
Interface

= **#VALUE!** feet

None

Reference	Total change in pressure difference between Test and
	X X X X

0.0 hours.

Company: **Morton Salt** Facility: **Glendale, AZ** Field: **RB # 5** Test Well: **Annulus**

Date: _____

17. 36 Hour Temperature Equilibrium Period (Continued)

b. Comment on whether the change in pressure difference indicates significant movement of the interface during the temperature equilibrium period:

No significant change

c. For information purposes only, what other wells in the gallery were operated during the temperature equilibrium period? RB # 5

18. Test

The test extends over eight hours with pressure measurements taken every two hours.

a. Take pressure measurements

	Date	Time	Reading No.	Test well pressure, psi	Reference well pressure, psi	Pressure difference between Test and Reference wells, psi	2 hour change in pressure difference between Test and Reference wells, psi
Start of test*			1			0.000	X X X X
2 hours after start			2			0.000	0.000
4 hours after start			3			0.000	0.000
6 hours after start			4			0.000	0.000
8 hours after start, final reading			5			0.000	0.000
	Total time (hours and tenths)	ERROR!				Total change in pressure difference between Test and Reference wells, psi	**0.000**

* Same as the final reading for the temperature equilibrium period, step 17a.

b. For information purposes only, what other wells in the gallery were operated during the test period? None

c. Calculate the average rate of change in the pressure difference for the eight hour test period.

$$\frac{\text{Total change in pressure difference between Test and Reference wells, psi}}{\text{Total time of test, hours}} = \frac{0.000}{\text{ERROR!}} = \text{ERROR!} \text{ psi/hour}$$

Company: **Morton Salt** Facility: **Glendale, AZ** Field: **RB # 5** Test Well: **Annulus** Date: _____

18. Test (Continued)

d. Evaluate the consistency of the test data by calculating the population standard deviation for the changes in pressure difference between the Test and Reference wells for the four 2 hour test periods in step 18a. **This evaluation is a Morton International Salt Group standard, it is not required by the U.S. EPA.**

x = the 2 hour change in pressure difference between test and reference wells, psi. n = number of measurements = 4

	x	x^2
0 to 2 hours	0.000	0.0000
2 to 4 hours	0.000	0.0000
4 to 6 hours	0.000	0.0000
6 to 8 hours	0.000	0.0000
S	0.000	0.0000

Population standard deviation

$$= \frac{1}{n}\sqrt{\; n\Sigma x^2 - (\Sigma x)^2}$$

Population standard deviation = 0.000 Data is Consistent

The population standard deviation should be less than 0.1; if it is greater, review with Solution Mining Manager, 312/807-2722.

If the population standard deviation is greater than 0.1 but the test is still considered to be valid, explain why the data consistency is still acceptable:

e. If the average change in pressure difference is less than 0.05 psi/hour (plus or minus) and the data is acceptable, the well has demonstrated mechanical integrity.

Pass or Fail? **ERROR!** (Also entered on page 1)

19. Witnesses for Regulatory Agencies

Names: Ryan Fitzpatrick
Organizations: ADEQ on behalf of the EPA region 9 office
Addresses and Telephones:

Company: **Morton Salt** Facility: **Glendale, AZ** Field: **RB # 5** Test Well: **Annulus** Date: _____

20. Person in Charge of Conducting the Test

The above report is true, accurate, and complete.

21. Certification The following certification is required by 40 CFR 144.32 (d). It must be signed by someone specifically authorized to sign under 40 CFR 144.32 (b).

22. Attachments

Field data sheets for test well. Number of sheets:
Field data sheets for reference well. Number of sheets:

Signature:

Printed Name:

Organization: Mor

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Authorized signature:

Name: Blain

Title: Facili

Organization: Mort

Address: 1300
Glen

Telephone: 623-

Company: **Morton Salt**

Date:

ton Salt, Inc

Telephone: 623-247-3000 x 3116

Date:

e Godfrey
.ty Manager
on Salt
0 W Glendale Ave
lale, AZ 85307
247-3000 x 3107

Facility: **Glendale, AZ** Field: **RB # 5** Test Well: **Annulus** Date:

16. Inject Water or Oil in Test Well to Establish Interface

a. Calculate the maximum injection rate for a maximum velocity of 20 feet per minute.

Capacity of casing or annulus _____ gal/ft x Maximum injection velocity 20 feet per minute = Maximum injection rate _____ gallons per minute

b. Explain how the injection rate will be controlled to insure that the maximum injection velocity will not exceed 20 feet per minute:

_____

c. Determine by calculation the desired change in the pressure difference between the test well and reference well before and after injecting the water or oil.

Target depth for interface (from step 7) _____ ft x (Specific gravity of brine in test well (3 _____ - Specific gravity of water or oil (3 decimals) _____) x Conversion factor 0.4331 psi/foot =

d. Inject water or oil

	Date	Time	Reading No.	Test well pressure, psi	Reference well pressure, psi	Pressure difference between Test and Reference wells, psi
Before Injecting						
1st reading while injecting*						
2nd reading while injecting*						
3rd reading while injecting*						
Final reading						

* Optional ** The pressure difference for this reading minus the original pressure difference.

Checks:

$$R = \frac{C \times 20}{D} = \text{psi/min}$$

= Maximum rate of change of pressure difference

Company: **Morton Salt** Facility: _____ Field: _____ Test Well: _____ Date:

Change in pressure difference

_____ psi

Total change in pressure difference between Test and Reference wells, psi **
X X X X

17. 36 Hour Temperature Equilibrium Period (Continued)

b. Comment on whether the change in pressure difference indicates significant movement of the interface during the temperature equilibrium period:

_____

c. For information purposes only, what other wells in the gallery were operated during the temperature equilibrium period? _____

18. Test

The test extends over eight hours with pressure measurements taken every two hours.

a. Take pressure measurements

	Date	Time	Reading No.	Test well pressure, psi	Reference well pressure, psi	Pressure difference between Test and Reference wells, psi	2 hour change in pressure difference between Test and Reference wells, psi
Start of test*							XXXX
2 hours after start							
4 hours after start							
6 hours after start							
8 hours after start, final reading							
	Total time (hours and tenths)					Total change in pressure difference between Test and Reference wells, psi	

* Same as the final reading for the temperature equilibrium period, step 17a.

b. For information purposes only, what other wells in the gallery were operated during the test period? _____

c. Calculate the average rate of change in the pressure difference for the eight hour test period.

$$\frac{\text{Total change in pressure difference between Test and Reference wells, psi}}{\text{Total time of test, hours}} = \frac{0.000}{0.0} = \text{\_\_\_\_\_ psi/hour}$$

Company: **Morton Salt** Facility: _____ Field: _____ Test Well: _____ Date: _____